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U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

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INTERNATIONAL APPLICATION NO.

PCT/JP00/03525

INTERNATIONAL FILING DATE

June 1, 2000

PRIORITY DATE CLAIMED

June 3, 1999 and July 2, 1999

TITLE OF INVENTION

PACKET COMMUNICATION APPARATUS AND TRANSMIT POWER CONTROL METHOD

APPLICANT(S) FOR DO/EO/US

Hideki KANEMOTO, Osamu KATO

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
 - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☐ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ Certificate of Mailing by Express Mail
20. ☒ Other items or information:

Claim for Priority with PCT/IB/304

PCT/IB/308

PCT/RO/101

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.53) <div style="font-size: 24pt; font-weight: bold; text-align: center;">09/744811</div>		INTERNATIONAL APPLICATION NO. <div style="font-weight: bold; text-align: center;">PCT/JP00/03525</div>		ATTORNEY'S DOCKET NUMBER <div style="font-weight: bold; text-align: center;">L9289.01104PCT</div>	
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21. The following fees are submitted:				CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :					
<input type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO				\$1,000.00	
<input checked="" type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO				\$860.00	
<input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO				\$710.00	
<input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4)				\$690.00	
<input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4)				\$100.00	
ENTER APPROPRIATE BASIC FEE AMOUNT =				\$860.00	
Surcharge of \$130.00 for furnishing the oath or declaration later than months from the earliest claimed priority date (37 CFR 1.492 (e)).				\$0.00	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	10 - 20 =	0	x \$18.00	\$0.00	
Independent claims	6 - 3 =	3	x \$80.00	\$240.00	
Multiple Dependent Claims (check if applicable).				\$0.00	
TOTAL OF ABOVE CALCULATIONS =				\$1,100.00	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) (check if applicable).				\$0.00	
SUBTOTAL =				\$1,100.00	
Processing fee of \$130.00 for furnishing the English translation later than months from the earliest claimed priority date (37 CFR 1.492 (f)).				\$0.00	
TOTAL NATIONAL FEE =				\$1,100.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable).				\$40.00	
TOTAL FEES ENCLOSED =				\$1,140.00	
				Amount to be: refunded	\$
				charged	\$

- ☒ A check in the amount of **\$1,140.00** to cover the above fees is enclosed.
- ☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees.
A duplicate copy of this sheet is enclosed.
- ☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **19-4375** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

James E. Ledbetter
 STEVENS, DAVIS, MILLER & MOSHER, LLP
 1615 L Street, NW, Suite 850
 Washington, DC 20036
 Tel: 202/408-5100
 Fax: 202/408-5200

SIGNATURE

James E. Ledbetter

NAME

28,732

REGISTRATION NUMBER

January 30, 2001

DATE

DESCRIPTION

PACKET COMMUNICATION APPARATUS AND TRANSMIT POWER
CONTROL METHOD

5 Technical Field

The present invention relates to a packet communication apparatus and transmit power control method used in a radio communication system.

10 Background Art

It is required in a packet communication for a receiving station to receive a packet or a transmission unit, which is obtained by dividing the packet into portions, transmitted from a transmitting station through a propagation path without data error. Therefore, the transmitting station generally performs error correcting coding per unit transmission portion, and the receiving station performs error detection and error correction per unit transmission portion.

It sometimes happens during the time a packet is transmitted that an error beyond the capability of the error correcting coding occurs on a transmission unit, and therefore cannot be corrected. In such a case, a receiving station abandons the packet, and requests a transmitting station to retransmit the packet.

In order to perform stable communications in the case of performing a packet communication in a radio

CODED: TERNES

communication where a propagation path environment changes rapidly, there is proposed a method in which power control is performed in addition to the above error correcting coding (Japan Laid Open Patent Publication
5 HEI9-233021). The power control is performed in such a way that a quality on a propagation path is estimated from a received signal, and deterioration on the propagation path is corrected corresponding to the estimated quality.

10 Specifically, a receiving station detects a quality of received signal per packet or unit transmission portion, estimates a propagation path environment based on the received quality, generates power control information corresponding to the
15 propagation path environment, and transmits a signal including the power control information to a transmitting station. The transmitting station adjusts transmit power based on the power control information.

FIG.1 is a schematic view showing a quality of
20 received signal and power control status in a conventional packet communication apparatus when a propagation path quality deteriorates for a long term. In FIG.1, reference numeral "1" denotes a transmission packet, and reference numeral "2" denotes a transmission
25 unit. Reference numeral "3" denotes a change in the received quality in a packet receiving station.

When the received quality, i.e., received quality

3 deteriorates on transmission packet 1 or unit
transmission portion 2, a transmitting station performs
control for increasing transmit power successively a
plurality of times. According to the control, the
5 transmitting station increases the transmit power
successively as shown in FIG.1.

However, in such a condition that the control for
increasing the transmit power is performed successively,
it is considered to happen often that there is an error
10 on a transmission unit received before the transmit power
is increased, or an error that cannot be corrected occurs
on a transmission unit that is transmitted with increased
transmit power, and that retransmission of the packet
is needed because the packet is not constructed.

15 Therefore, although the power control is performed
based on a quality of received signal and transmit power
is increased, when retransmission of a packet is needed
because there is an error on a transmission unit received
before the transmit power is increased, or an error that
20 cannot be corrected occurs on a transmission unit, the
retransmission of the packet is sometimes unavoidable
due to the error on the received unit transmission
portion. Further, increasing the transmit power may
increase interference in peripheral communication
25 stations. Accordingly in this case, the power is
consumed wastefully, resulting in a problem that an
efficient packet communication is not performed.

Disclosure of Invention

It is an object of the present invention to provide an efficient packet communication apparatus and transmit
5 power control method capable of achieving battery saving without increasing extra interference in other communication stations.

It is a subject matter of the present invention that when a communication channel condition is poor, power
10 control information is stored without increasing transmit power on transmission units in a packet under the poor condition, and the control information is reflected in transmitting a next packet, whereby interference in peripheral communication stations is
15 decreased, the efficiency of the packet communication is increased, and total transmit power is decreased, thereby enabling battery saving.

Brief Description of Drawings

20 FIG.1 is a schematic view showing a quality of received signal and power control status in a conventional packet communication apparatus;

FIG.2 is a block diagram illustrating a configuration of a packet communication apparatus
25 according to a first embodiment of the present invention;

FIG.3 is a schematic view showing a quality of received signal and power control status in the packet

communication apparatus according to the above embodiment;

FIG.4 is a flowchart to explain an operation of the packet communication apparatus according to the above
5 embodiment;

FIG.5 is a block diagram illustrating a configuration of a packet communication apparatus according to a second embodiment of the present invention;

10 FIG.6 is a schematic view showing a quality of received signal and power control status in the packet communication apparatus according to the above embodiment; and

FIG.7 is a flowchart to explain an operation of the
15 packet communication apparatus according to the above embodiment.

Best Mode for Carrying Out the Invention

Embodiments of the present invention are explained
20 specifically below with reference to accompanying drawings.

(First embodiment)

The first embodiment explains a constitution that a packet undergoing control for increasing transmit
25 power a plurality of times successively is judged to have a high possibility that the packet is retransmitted because the packet has an error that makes it impossible

to construct the packet after receiving it, transmit power is thereby not increased on transmission units in the packet after the control is performed the plurality of times, power control information is stored, and that
5 the control information is reflected in transmitting a next packet.

FIG.2 is a block diagram illustrating a configuration of a packet communication apparatus according to the first embodiment of the present
10 invention.

A signal transmitted from a communication partner is received at radio reception section 102 through antenna 101. Radio reception section 102 performs on the received signal processing of amplification (gain control), downconverting and A/D conversion. The A/D
15 converted signal is output to demodulation section 105, and is demodulated to be received data. The A/D converted signal is further output to received quality detecting section 103 and transmit power information
20 extracting section 106.

Received quality detecting section 103 measures, for example, SIR (Signal to Interference Ratio) and received power to detect a quality of received signal. The detected result of the received quality is output
25 to determining section 104. Based on the detected result, determining section 104 determines whether to increase, maintain or decrease transmit power, and

outputs transmit power instruction information to modulation section 108.

Transmit power information extracting section 106 extracts the transmit power instruction information from
5 the A/D converted signal, and inputs the transmit power instruction information to counter 1071 in transmit power control section 107.

In transmit power control section 107, counter 1071 counts the number of pieces of input transmit power
10 instruction information. Counting control section 1072 in transmit power control section 107 controls transmit power in radio reception section 109 according to the transmit power instruction information, while observing the count number of counter 1071 to instruct start and
15 halt of transmit power control. Further, counting control section 1072 performs reset of counter 1071. Memory 1073 stores transmit power instruction information therein.

Meanwhile, transmission data is output to
20 modulation section 108 as well as the transmit power instruction information to be modulated, and then output to radio transmission section 109. Radio transmission section 109 performs on the modulated signal processing of D/A conversion, upconverting and
25 amplification (gain control). Thus processed signal is transmitted through antenna 101 as a transmission signal.

An explanation is given of the operation of the packet communication apparatus with the above configuration.

Radio reception section 102 performs predetermined
5 processing on a received signal, and outputs the resultant signal to transmit power information extracting section 106. Transmit power instruction information extracted in transmit power information extracting section 106 is input to counter 1071 in
10 transmit power control section 107. According to the transmit power instruction information, transmit power control section 107 provides an instruction for increasing or decreasing transmit power to radio transmission section 109, while when the section 107
15 receives the instruction information for increasing the power a predetermined number of times successively, storing the transmit power information in memory 1073 without increasing the transmit power of transmission units in a packet after receiving the information a
20 predetermined number of times, and reflecting the transmit power information collectively at the time of starting transmitting a next packet.

Specifically, counter 1071 first counts the number of times the transmit power instruction information
25 indicative of increasing the power is repeated successively. Counting control section 1072 observes whether or not the instruction information for

increasing the power is repeated successively a predetermined number of times. For example, the count number of the instruction information for increasing the power is compared with a threshold.

5 Then, when transmit power control section 107 detects a situation that the instruction information for increasing the power is repeated successively a predetermined number of times, for example, when the number of times the instruction information for
10 increasing the power is repeated successively exceeds a predetermined threshold, the section 107 does not provide an instruction signal for increasing the power to radio transmission section 109 with respect to transmission units after the situation, and stores the
15 instruction information in memory 1073. After that, at the time of transmitting a next packet, the section 107 fetches the instruction information stored in memory 1073, and outputs the instruction signal to radio transmission section 109 so as to reflect all the
20 instruction information.

Meanwhile, when the instruction information for increasing the power is not repeated successively a predetermined number of times, transmit power control section 107 outputs the instruction signal for
25 increasing or decreasing the power to radio transmission section 109 according to the transmit power instruction information. Radio transmission section 109 adjusts a

gain according to the instruction signal using a gain controller such as an amplifier, and thereby performs transmit power control.

The power control is performed as shown in FIG.3.

5 Packet 201 is divided into a plurality of transmission units 202 to be transmitted sequentially. When received quality 203 deteriorates due to a variation in a propagation path, power control instruction information for increasing transmit power is output under the

10 transmit power control. In this case, when the instruction for increasing the power is repeated a predetermined number of times (four times in FIG.4), the transmit power control is halted. In FIG.3, the last unit transmission portion of the packet does not undergo

15 the transmit power control. In this case, the power control instruction information on the last unit transmission portion of the packet is stored in the memory, and is reflected in the transmit power control on a beginning unit transmission portion of a next packet.

20 Proper transmit power control is thereby performed starting from a next packet signal. It is therefore possible to perform efficient communications while decreasing interference in other stations.

The transmit power control method as described

25 above is next explained using a flowchart in FIG.4.

At step (hereinafter abbreviated as ST) 301, power control instruction information is extracted from a

received signal. At ST302, it is judged that a flag is set indicative of that the power control instruction information is repeated successively a predetermined number of times.

5 When the flag is not set, it is judged that the power control instruction information is indicative of increasing power and that the power increasing instruction is repeated successively a predetermined number of times (ST303). When the power increasing
10 instruction is repeated successively a predetermined number of times, the flag is set (ST304), while when the power increasing instruction is not repeated successively a predetermined number of times, the power control is performed according to the power control
15 instruction information (ST307). Further, when the flag is set, the power control instruction information is stored in the memory (ST305), and the power control is halted (ST306).

 When the power increasing instruction is repeated
20 successively a predetermined number of times, the power control instruction information is stored in the memory (ST305), and the power control is halted (ST306). Then, the power control instruction information stored in the memory is reflected in the transmit power control on a
25 beginning unit transmission portion of a next packet.

A situation that the control for increasing transmit power is repeated successively indicates that

a condition is continued that increasing the transmit power does not sufficiently compensate for deterioration of a received signal quality due to propagation path degradation. In this case, it is considered that
5 transmission units are not received accurately, and that a possibility that a packet is eventually retransmitted is high.

According to the transmit power control method of this embodiment, successive pieces of power control
10 instruction information are counted, and when the control information for increasing the power is repeated successively a predetermined number of times or more, the power control is halted and the power control information is only stored, whereby it is possible to
15 suppress wasteful power consumption by not increasing the transmit power. Further, the stored power control instruction information is reflected in a transmission unit of a next slot, thereby enabling the packet to be transmitted assuredly.

20 Furthermore, since transmission is not performed with unreasonable high power on a poor communication channel, it is possible to reduce interference in peripheral communication stations, increase the efficiency of the packet communication, decrease the
25 total transmit power, and achieve battery saving.

(Second embodiment)

The second embodiment explains a constitution that

with respect to a packet undergoing control for increasing transmit power a plurality of times successively, the transmit power of only a pilot signal portion for use by a receiving side in determining a quality of received signal is increased in unit transmission portion of the slot after the control is repeated the plurality of times, and that the transmit power of a last pilot signal portion is reflected in whole transmission units at the time of transmitting a next slot.

FIG.5 is a block diagram illustrating a configuration of a packet communication apparatus according to the second embodiment of the present invention. In addition, in FIG.5, the same sections as those illustrated in FIG.2 are assigned the same reference numerals as those in FIG.2 to omit detailed explanations thereof.

In the configuration illustrated in FIG.5, a configuration of transmit power control section 401 is different from a corresponding configuration illustrated in FIG.2. That is, transmit power control section 401 has counter 4011 that counts the number of pieces of transmit instruction information, counting control section 4012 that controls transmit power on a control channel for transmitting, for example, a pilot signal, and transmit power on a data channel for transmitting data independently to increase or decrease

respective power corresponding to the count number of counter 4011, control channel power control section 4013 that performs power control on the control channel, and data channel power control section 4014 that performs
5 power control on the data channel.

An explanation is given of the operation of the packet communication apparatus with the above configuration.

Radio reception section 102 performs predetermined
10 processing on a received signal, and outputs the resultant signal to transmit power information extracting section 106. Transmit power instruction information extracted in transmit power information extracting section 106 is input to counter 4011 in
15 transmit power control section 401. According to the transmit power instruction information, transmit power control section 401 provides an instruction for increasing or decreasing transmit power on the control channel to radio processing section 109, while when the
20 section 401 receives the instruction information for increasing the power successively a predetermined number of times successively, the section 401 does not increase the transmit power of transmission units in a packet on the data channel after receiving the information a
25 predetermined number of times. Then, on the data channel, the transmit power of a last control signal portion is reflected in transmit power of signal portions

on the data channel (data signal portions) at the time of starting transmitting a transmission unit of a next slot.

Specifically, counter 4011 counts the number of times the transmit power instruction information indicative of increasing the power is repeated successively for the data channel. Count control section 4011 observes whether or not the instruction information for increasing the power is repeated successively a predetermined number of times. For example, the count number of the instruction information for increasing the power is compared with a threshold.

Then, when transmit power control section 401 detects a situation that the instruction information for increasing the power is repeated successively a predetermined number of times, for example, when the number of times the instruction information for increasing the power is repeated successively exceeds a predetermined threshold, the section 401 outputs an instruction signal for halting the power control on transmission units after the situation to data channel power control section 4014. Data channel power control section 4014 controls radio transmission section 109 so that the section 109 halts the power control on transmission units after the situation on the data channel.

Meanwhile, on the control channel, control channel

power control section 4013 controls radio transmission section 109 so that the section 109 increases or decreases the power according to the transmit power instruction information. Radio transmission section 5 109 adjusts a gain according to the instruction signal using a gain controller such as an amplifier, and thereby performs transmit power control.

Then, with respect to the control channel, counting control section 4012 instructs radio transmission 10 section 109 to reflect the transmit power of a last control signal portion (for example, pilot signal portion) in transmit power of data signal portions at the time of starting transmitting a transmission unit of a next slot.

15 The transmit power is performed as shown in FIG.6. Packet 501 is divided into a plurality of transmission units 502 to be transmitted sequentially. When received quality 503 deteriorates due to a variation in a propagation path, power control instruction for 20 increasing transmit power is output under the transmit power control.

In this case, when the instruction for increasing the power is repeated a predetermined number of times (four times in FIG.6), the transmit power control is 25 halted on data signals. In FIG.6, the last unit transmission portion of the packet does not undergo the transmit power control. Meanwhile, the transmit power

control is performed on each unit transmission portion of a pilot signal to be transmitted on the control channel according to the power instruction information. Then, on the data channel, the transmit power control is performed on a beginning unit transmission portion of a next packet according to the power instruction information of a last pilot signal. In other words, on a data signal, an amount denoted with "H" corresponding to the transmit power instruction information in FIG.5 is reflected in the beginning unit transmission portion of the next packet.

The transmit power control method as described above is next explained using a flowchart in FIG.7.

At ST 601, power control instruction information is extracted from a received signal. At ST602, it is judged that a flag is set indicative of that the power control instruction information is repeated successively a predetermined number of times.

When the flag is not set, it is judged that the power control instruction information is indicative of increasing power and that the power increasing instruction is repeated successively a predetermined number of times (ST603). When the flag is set, transmit power control is performed only on a pilot signal portion of a control channel according the power control instruction information (ST605). In other words, the transmit power control is halted on a signal portion of

data channel.

Further, when the power increasing instruction is repeated successively a predetermined number of time, the flag is set (ST604), and the transmit power control is performed on only a pilot signal portion of the control channel according to the power control instruction information (ST605). In other words, the transmit power control is halted on a data signal portion.

When the power increasing instruction is not repeated successively a predetermined number of times, the power control is performed on the data channel and control channel for each unit transmission portion according to the power control instruction information (ST606).

A situation that the control for increasing transmit power is repeated successively indicates that a condition is continued that increasing the transmit power does not sufficiently compensate for deterioration of a received signal quality due to propagation path degradation. In this case, it is considered that transmission units are not received accurately, and that a possibility that a packet is eventually retransmitted is high.

According to the transmit power control method of this embodiment, successive pieces of power control instruction information are counted, and when the control information for increasing the power is repeated

FOOTNOTES

a predetermined number of times or more, the transmit power on a pilot signal portion control is only increased, and the transmit power on a data signal portion is not increased. It is thereby possible for the power control

5 to continue to operate accurately between a transmitting station and a receiving station that judges a quality of received signal from the pilot signal portion without forcing the transmitting side to transmit signals with unnecessary high power. As a result, it is possible to

10 reduce interference in peripheral stations and increase the efficiency of packet communication. Further, the power control instruction information on a pilot signal portion is reflected at the time of starting the transmit power control on a data signal portion, whereby it is

15 possible to transmit packets assuredly.

On a poor communication channel, thus controlling transmit power of a pilot signal portion and data signal portion separately enables the power control to continue to operate accurately and further enables transmission

20 not to be performed with unreasonable high power. It is thereby possible to reduce interference in peripheral stations, increase the efficiency of packet communications, and perform more proper transmit power control in transmitting a next packet.

25 The packet communication apparatus according to either of the above first and second embodiments is applicable to a base station apparatus and a

communication terminal apparatus such as a mobile station in a digital radio communication system. It is thereby possible to achieve radio communications with high efficiency without consuming power wastefully.

5 A packet communication apparatus of the present invention adopts a configuration having an extractor that extracts transmit power control information from a packet signal comprised of transmission units each including the transmit power control information, a
10 determiner that determines quality deterioration of the packet signal, and a controller that performs control for halting transmit power control on a transmission unit to be transmitted after determining the quality deterioration on the packet signal, based on a determined
15 result.

According to this configuration, since the power control is halted and the power control information is only stored when a quality of the packet signal deteriorates, whereby it is possible to suppress
20 wasteful power consumption by not increasing the transmit power.

Further, since transmission is not performed with unreasonable high power on a poor communication channel, it is possible to reduce interference in peripheral
25 communication stations, increase the efficiency of the packet communication, decrease the total transmit power, and achieve battery saving.

A packet communication apparatus of the present invention adopts another configuration having storage that stores the transmit power control information for the unit transmission portion to be transmitted after
5 determining the quality deterioration on the packet signal, where based on the transmit power control information stored in the storage, the controller performs the transmit power control on a beginning unit transmission portion of a next packet.

10 According to this configuration, since the stored power control instruction information is reflected in a transmission unit of a next packet, it is possible to transmit the packet assuredly. Further, proper transmit power control can be performed starting from
15 a next packet signal. It is therefore possible to perform efficient communications while decreasing interference in other stations.

A packet communication apparatus of the present invention adopts another configuration having an
20 extractor that extracts transmit power control information from packet signals each comprised of transmission units each including the transmit power control information, the packet signals being transmitted using a data channel and a control channel,
25 a determiner that determines quality deterioration of the packet signals, and a controller that performs control for halting transmit power control on a

transmission unit to be transmitted after determining the quality deterioration on a packet signal for the data channel signal, based on a determined result.

According to this configuration, on a poor
5 communication channel, thus controlling transmit power of a pilot signal portion and data signal portion separately enables power control to continue to operate accurately and further enables transmission not to be performed with unreasonable high power. It is thereby
10 possible to reduce interference in peripheral stations, increase the efficiency of packet communications, and perform more proper transmit power control in transmitting a next packet.

A packet communication apparatus of the present
15 invention adopts another constitution where based on the transmit power control information for a last unit transmission portion of the packet signal on the control channel, the controller performs the transmit power control on a beginning unit transmission portion of a
20 next packet on the data channel.

According to this constitution, the power control instruction information of a pilot signal portion is reflected at the time of starting the transmit power control on a data signal portion, whereby it is possible
25 to transmit packets assuredly.

In the packet communication apparatus of the present invention, it is preferable for the determiner

to determine the quality deterioration using the number of times the transmit power control information for increasing transmit power is repeated successively.

A communication terminal apparatus of the present invention is characterized by having the above packet communication apparatus. A base station apparatus of the present invention is characterized by having the above packet communication apparatus. According to these constitutions, it is possible to achieve efficient radio communications without consuming power wastefully.

A transmission power control method of the present invention has the steps of extracting transmit power control information from a packet signal comprised of transmission units each including the transmit power control information, determining quality deterioration of each of the packet signals, performing control for halting transmit power control on a transmission unit to be transmitted after determining the quality deterioration on the packet signal, based on a determined result, and performing the transmit power control on a beginning unit transmission portion of a next packet based on the transmit power control information for a transmission unit after determining the quality deterioration on the packet signal.

According to this method, since the power control is halted and the power control information is only

stored when a quality of the packet signal deteriorates,
whereby it is possible to suppress wasteful power
consumption by not increasing the transmit power.
Further, since transmission is not performed with
5 unreasonable high power on a poor communication channel,
it is possible to reduce interference in peripheral
communication stations, increase the efficiency of the
packet communication, decrease the total transmit power,
and achieve battery saving.

10 Furthermore, since the stored power control
instruction information is reflected in a transmission
unit of a next packet, it is possible to transmit the
packet assuredly. Moreover proper transmit power
control can be performed starting from a next packet
15 signal. It is therefore possible to perform efficient
communications while decreasing interference in other
stations.

A transmit power control method of the present
invention has the steps of extracting transmit power
20 control information from packet signals each comprised
of transmission units each including the transmit power
control information, the packet signals being
transmitted using a data channel and a control channel,
determining quality deterioration of each of the packet
25 signals, performing control for halting transmit power
control on a transmission unit to be transmitted after
determining the quality deterioration on a packet signal

for the data channel signal, based on a determined result,
and performing the transmit power control on a beginning
unit transmission portion of a next packet on the data
channel, based on the transmit power control information
5 for a last unit transmission portion in the packet signal
on the control channel.

According to the method, on a poor communication
channel, thus controlling transmit power of a pilot
signal portion and data signal portion separately
10 enables power control to continue to operate accurately
and further enables transmission not to be performed with
unreasonable high power. It is thereby possible to
reduce interference in peripheral stations, increase the
efficiency of packet communications, and perform more
15 proper transmit power control in transmitting a next
packet.

In the transmit power control method of the present
invention, it is preferable to determine the quality
deterioration using the number of times the transmit
20 power control information for increasing transmit power
is repeated successively.

The present invention is not limited to the
above-mentioned embodiments, and is capable of being
carried into practice with various modifications thereof.
25 For example, while the above embodiments explain the case
where as a method of determining quality deterioration,
the method is used of counting the number of times the

instruction for increasing transmit power is repeated successively, another method is applicable in the present invention as the method of determining quality deterioration. In other words, the method of
5 determining quality deterioration is not limited to any particular one in the present invention.

As described above, the packet communication apparatus of the present invention is capable of performing power control adapted to packet
10 communications, suppressing excessive power control for compensating for deterioration of communication path quality, and decreasing interfering power in peripheral communication stations and also total transmit power.

This application is based on the Japanese Patent
15 Applications No.HEI11-156663 filed on June 3, 1999, and No.HEI11-188649 filed on July 2, 1999, entire contents of which are expressly incorporated by reference herein.

Industrial Applicability

20 The present invention is applicable to a base station apparatus and communication terminal apparatus in a digital radio communication system.

CLAIMS

1. A packet communication apparatus comprising:
extracting means for extracting transmit power
control information from a packet signal comprised of
5 transmission units each including the transmit power
control information;

determining means for determining quality
deterioration of the packet signal; and

control means for performing control for halting
10 transmit power control on a transmission unit to be
transmitted after determining the quality deterioration
on the packet signal, based on a determined result.

2. The packet communication apparatus according to
claim 1, further comprising:

15 storage means for storing the transmit power
control information for the unit transmission portion
to be transmitted after determining the quality
deterioration on the packet signal;

wherein based on the transmit power control information
20 stored in the storage means, the control means performs
the transmit power control on a beginning unit
transmission portion of a next packet.

3. A packet communication apparatus comprising:
extracting means for extracting transmit power
25 control information from packet signals each comprised
of transmission units each including the transmit power
control information, the packet signals being

transmitted using a data channel and a control channel;

determining means for determining quality deterioration of each of the packet signals; and

control means for performing control for halting
5 transmit power control on a transmission unit to be transmitted after determining the quality deterioration on a packet signal for the data channel signal, based on a determined result.

4. The packet communication apparatus according to
10 claim 3, wherein based on the transmit power control information for a last unit transmission portion of the packet signal on the control channel, the control means performs the transmit power control on a beginning unit transmission portion of a next packet on the data
15 channel.

5. The packet communication apparatus according to claim 1, wherein the determining means determines the quality deterioration using the number of times the transmit power control information for increasing
20 transmit power is repeated successively.

6. A communication terminal apparatus provided with a packet communication apparatus, said packet communication apparatus comprising:

extracting means for extracting transmit power
25 control information from a packet signal comprised of transmission units each including the transmit power control information;

determining means for determining quality deterioration of the packet signal; and

control means for performing control for halting transmit power control on a transmission unit to be
5 transmitted after determining the quality deterioration on the packet signal, based on a determined result.

7. A base station apparatus provided with a packet communication apparatus, said packet communication apparatus comprising:

10 extracting means for extracting transmit power control information from a packet signal comprised of transmission units each including the transmit power control information;

determining means for determining quality
15 deterioration of the packet signal; and

control means for performing control for halting transmit power control on a transmission unit to be transmitted after determining the quality deterioration on the packet signal, based on a determined result.

20 8. A transmit power control method comprising the steps of:

extracting transmit power control information from a packet signal comprised of transmission units each including the transmit power control information;

25 determining quality deterioration of the packet signal;

performing control for halting transmit power

control on a transmission unit to be transmitted after determining the quality deterioration on the packet signal, based on a determined result; and

performing the transmit power control on a beginning unit transmission portion of a next packet, based on the transmit power control information for a transmission unit after determining the quality deterioration on the packet signal.

9. A transmit power control method comprising the steps of:

extracting transmit power control information from packet signals each comprised of transmission units each including the transmit power control information, the packet signals being transmitted using a data channel and a control channel;

determining quality deterioration of each of the packet signals;

performing control for halting transmit power control on a transmission unit to be transmitted after determining the quality deterioration on a packet signal for the data channel signal, based on a determined result; and

performing the transmit power control on a beginning unit transmission portion of a next packet on the data channel, based on the transmit power control information for a last unit transmission portion in the packet signal on the control channel.

10. The transmit power control method according to
claim 8, wherein the quality deterioration is determined
using the number of times the transmit power control
information for increasing transmit power is repeated
5 successively.

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When a transmitting station successively undergoes control for increasing transmit power, the station does not increase the power on a packet, and reflects the power control in transmitting a next packet. Otherwise, the station increases the power only of a pilot signal portion for use in determining a quality of received signal without increasing the power of a data portion in the packet, and adjusts the transmit power of the data portion using that of the pilot portion in transmitting a next packet.

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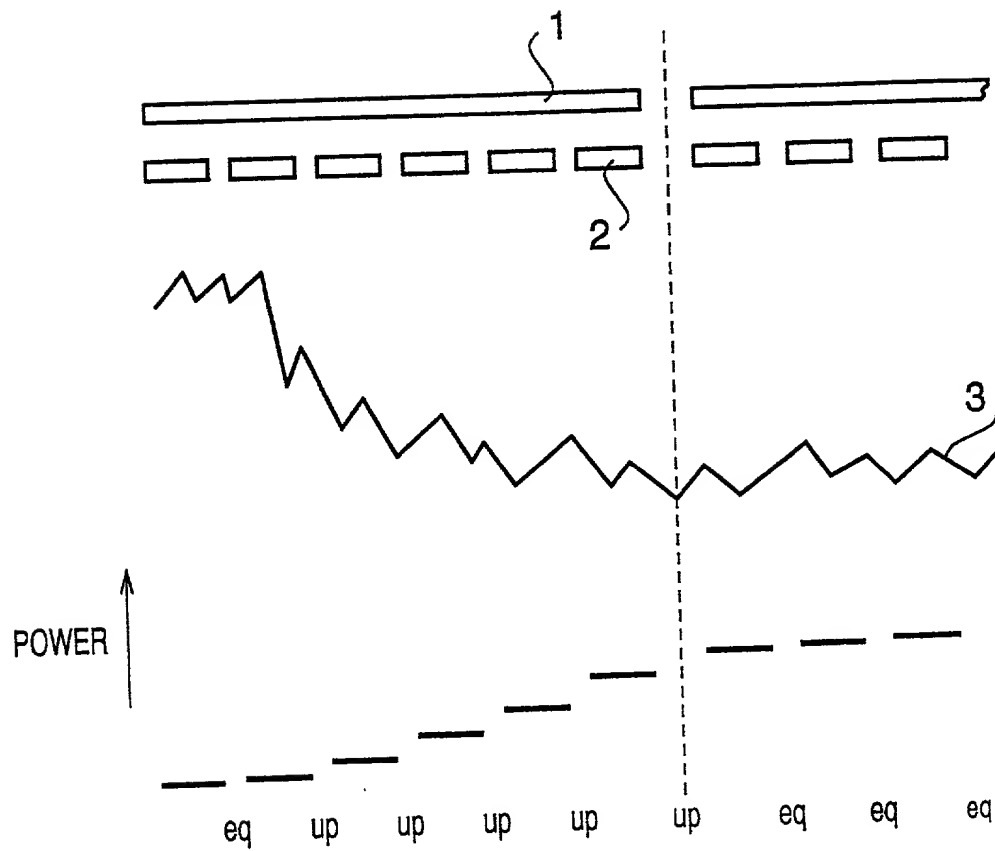


FIG. 1

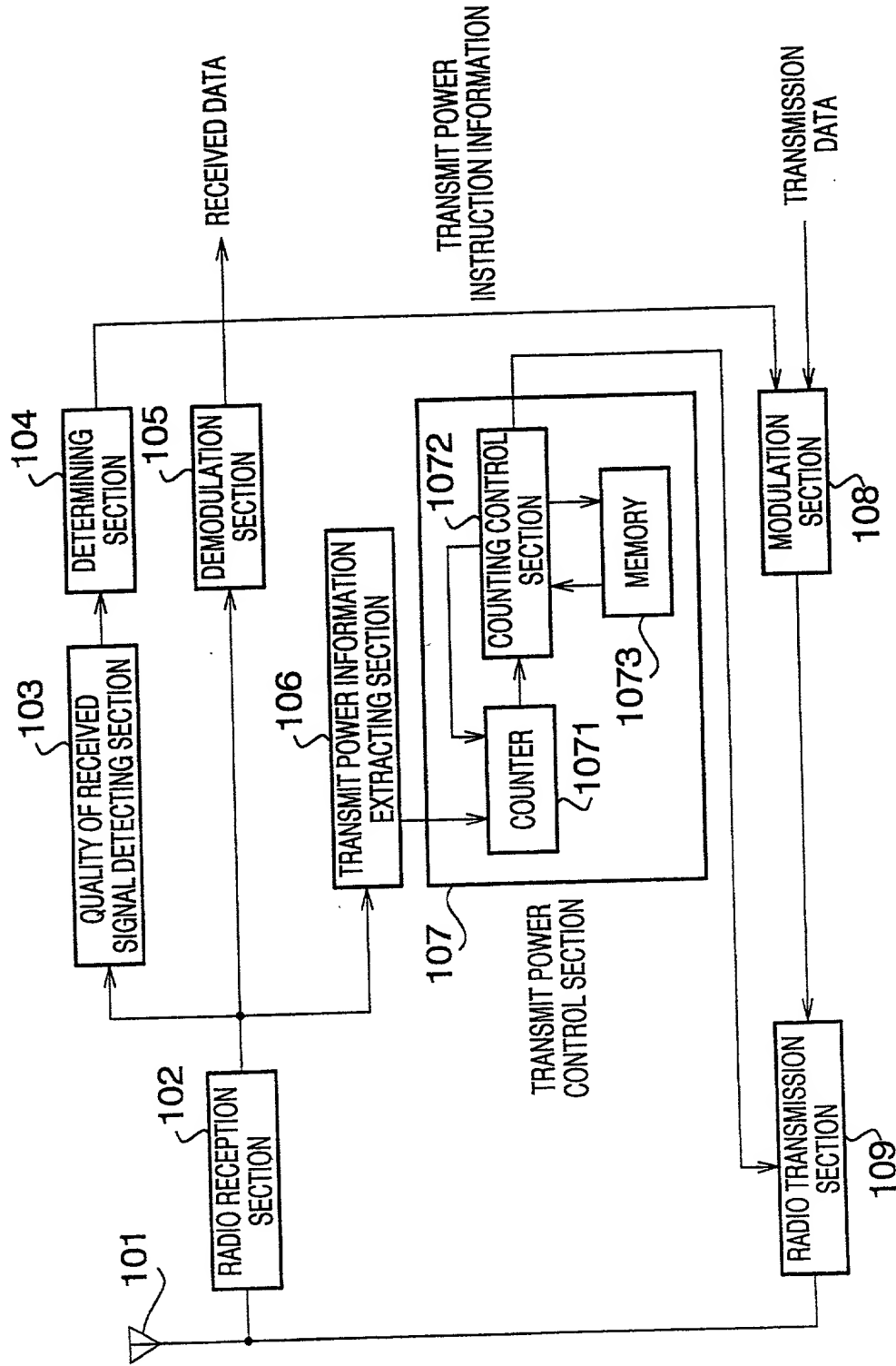


FIG. 2

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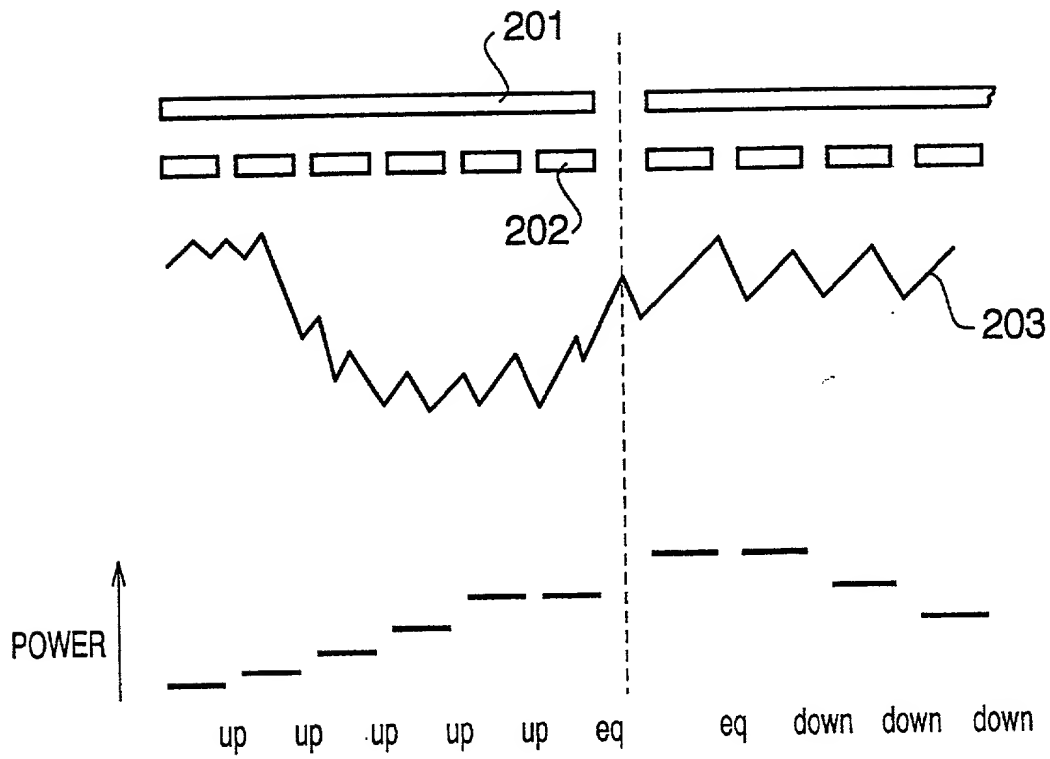


FIG. 3

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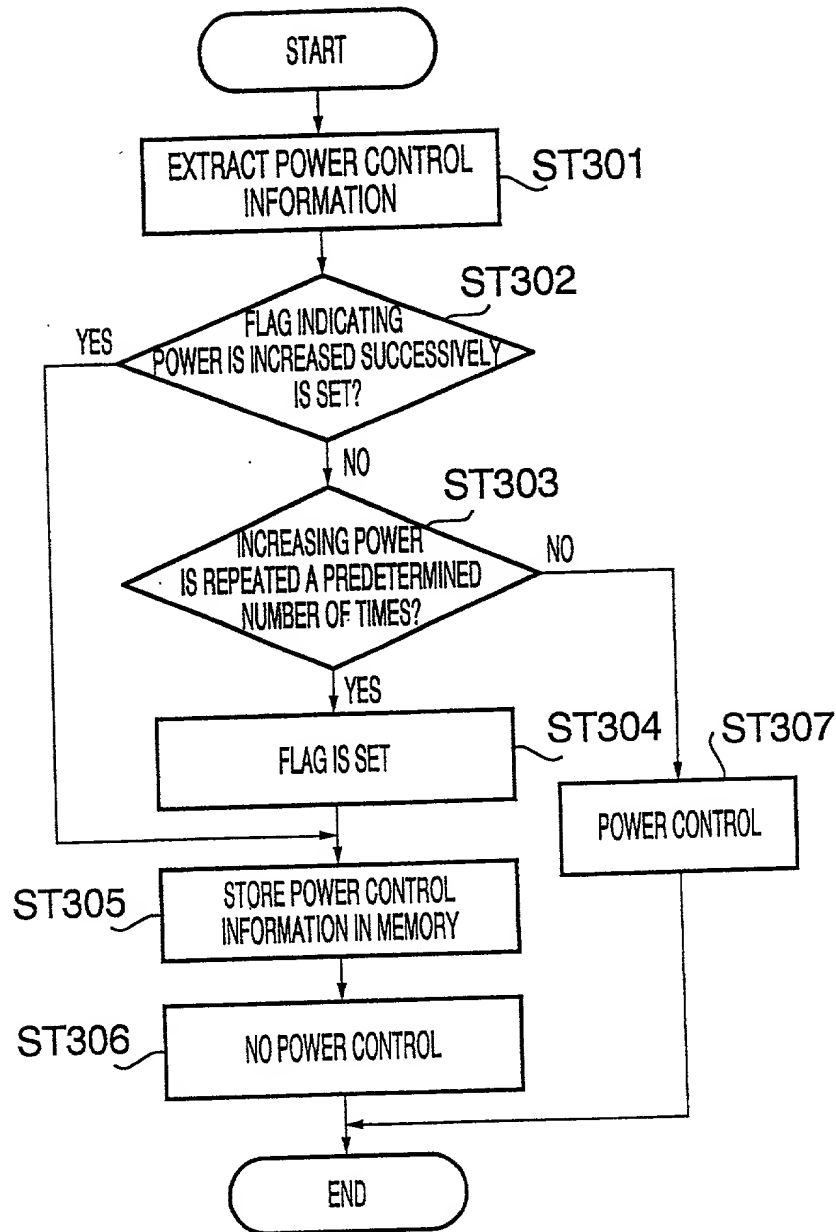


FIG. 4

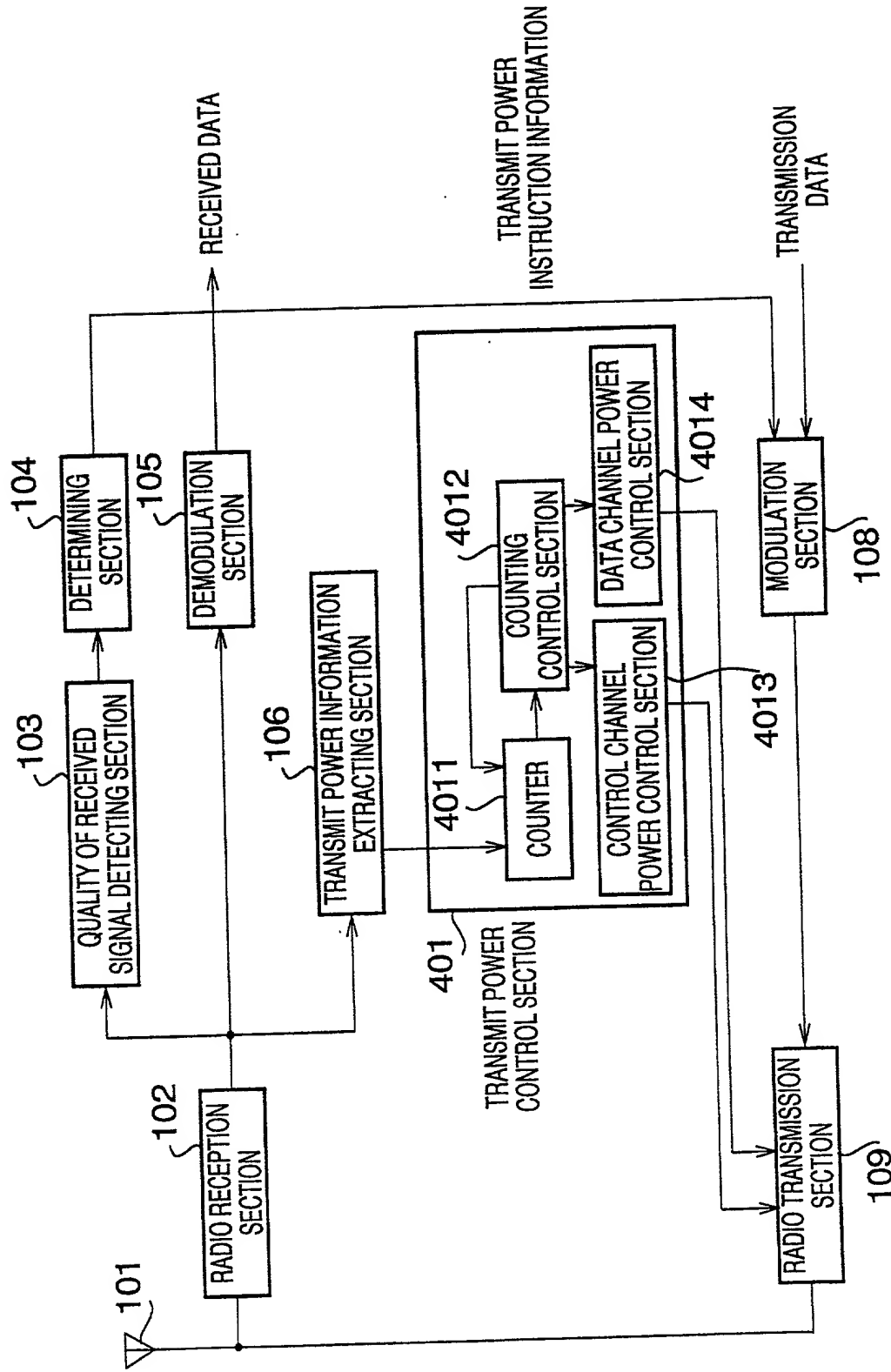


FIG. 5

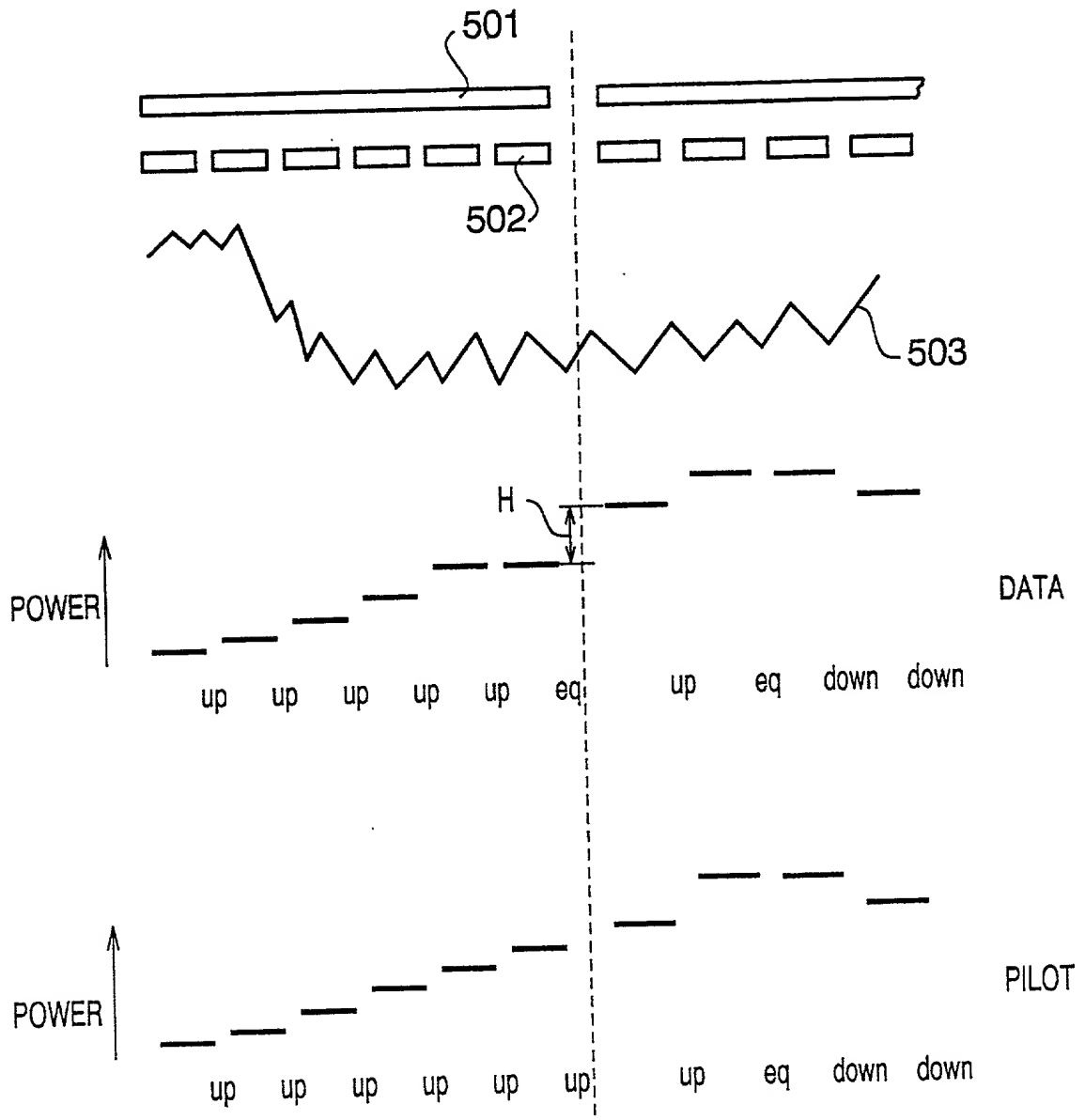


FIG. 6

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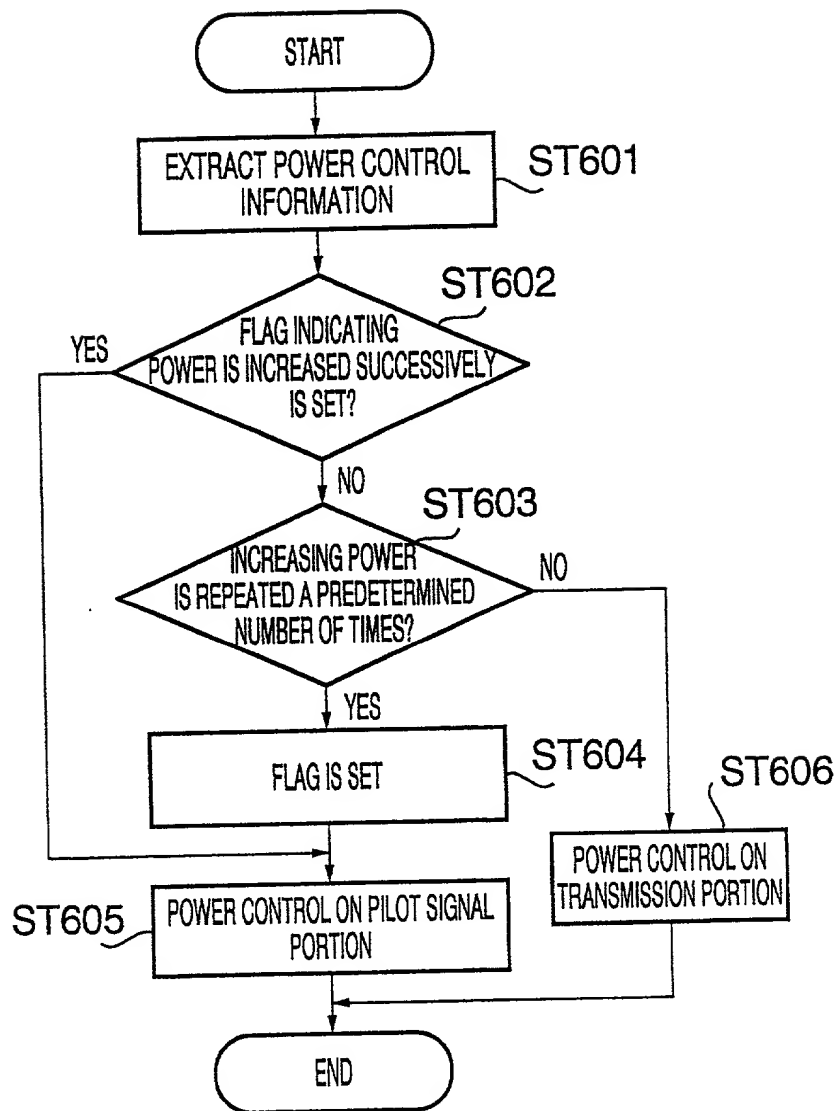


FIG. 7

APPLICATION FOR UNITED STATES PATENT
Declaration for Patent Application

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on

the invention entitled: PACKET COMMUNICATION APPARATUS AND TRANSMIT POWER CONTROL METHOD

the specification of which 2 (file no _____)

(check at least one) 3 ☒ is attached hereto
4 ☐ was filed on _____ as (5) U.S. Application Serial No. _____
6 ☐ and was amended _____
(if applicable)

Use this portion only if you are entering the U.S. National phase based on a PCT International Application designating the U.S.	7 <input checked="" type="checkbox"/>	was filed as PCT international application		
	8	Number <u>PCT/JP00/03525</u>		
	9	on <u>June 1, 2000</u>		
		and was amended under PCT Article(s) 19 and/or 34		
	10	on _____ (if applicable).		
	11	priority date claimed in PCT International Application		
	<u>JAPAN</u> (Country)	<u>JP11-156663</u> (Number)	<u>3/June/1999</u> (Day/Month/Year Filed)	
	<u>JAPAN</u> (Country)	<u>JP11-188649</u> (Number)	<u>2/July/1999</u> (Day/Month/Year Filed)	
	_____ (Country)	_____ (Number)	_____ (Day/Month/Year Filed)	

I hereby declare that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended, by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me which is material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date earlier than that of the application(s) on which priority is claimed.

Prior (Foreign) Application(s) any Priority Claims Under 35 U.S.C. 119			Priority Claimed	
12a	_____ (Country)	_____ (Number)	_____ (Day/Month/Year Filed)	<input type="checkbox"/> Yes <input type="checkbox"/> No
	_____ (Country)	_____ (Number)	_____ (Day/Month/Year Filed)	<input type="checkbox"/> Yes <input type="checkbox"/> No

Priority Claim(s) from U.S. Provisional Application(s) – I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below:

12b	Application No.	Day/Month/Year Filed	Application No.	Day/Month/Year Filed
-----	-----------------	----------------------	-----------------	----------------------

Do not use this portion to identify a PCT application if the parent application is the U.S. National phase of the PCT application	I hereby claim the benefit under Title 35, United States Code, 120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between filing date of the prior application and the national or PCT international filing date of this application.		
	13	_____ (U.S. Application Number)	_____ (U.S. Filing Date)

I hereby appoint the following attorneys of the firm of Stevens, Davis, Miller & Mosher, L.L.P. as my attorneys of record with full power of substitution and revocation to prosecute this application and to transact all business in the Patent and Trademark Office:

James E. Ledbetter, Reg. No. 28732; Thomas P. Pavelko, Reg. No. 31689; and Anthony P. Venturino, Reg. No. 31674.

ALL CORRESPONDENCE IN CONNECTION WITH THIS APPLICATION SHOULD BE SENT TO
STEVENS, DAVIS, MILLER & MOSHER, L.L.P., 1615 L Street, N.W., Suite 850, Washington, D.C. 20036
TELEPHONE (202) 408-5100, FACSIMILE (202) 408-5200.

See page 2 for signature lines

INSTRUCTIONS FOR COMPLETION OF THIS FORM

line 1 Insert the same title as is used on the specification and in the assignment.

line 2 Is optional but is provided so that you can use it to identify more readily an application prior to the time that the Patent Office application serial number is assigned. We suggest that the specification, drawings and declaration always bear a file number since it can help to get the papers together in case they become inadvertently separated. In instances where the specification is filed without a signed declaration form (under 37 CFR §1.53) a file number on a later-received separate form will assist us in associating it with the correct case.

line 3 Check this box if the specification, claims and drawing (if any) are attached to this declaration form, e.g., when filing a new patent application.

lines 4-5 Are only used in an instance where the application is already on file and the declaration from is being separately filed, e.g., when the application was originally filed without a signed declaration or where the Patent Office has required a new declaration because of a deficiency in the original declaration. In such an instance the Patent Office will require that lines 4 and 5 be completed with the filing date and application serial number already assigned.

line 6 Is used in conjunction with line 5 but only when there have been one or more amendments to the specification or claims. Line 6 is also used when the Examiner requires a new declaration because claims inserted by amendment cover subject matter not originally claimed (37 CFR §1.67).

lines 7-11 Are for PCT (Patent Cooperation Treaty) cases and are used only when you are entering the U.S. National phase (Chapter I or II) based upon a previously filed PCT International application designating the U.S.

line 7 Check this box if this is a PCT National Phase application.

line 8 Insert PCT International application number.

line 9 Insert date of filing of PCT International application.

lines 10-11 Insert the date of all amendments filed in the PCT International application. Such amendments are optional, so this line at times will not be used.

line 12a Is used in the following instances:

(i) If a single priority is being claimed from a foreign application you need to list only the first-filed application; you do not need to list other countries if all applications were filed within one year of the U.S. filing.

(ii) If multiple priorities are being claimed, from a plurality of applications filed in one or more countries, you must list the first filed application for each aspect of the invention. Example: if aspect A of the invention was disclosed in an application filed 11 months earlier in country X and aspect B was disclosed 9 months earlier in an application filed in country Y, then the applications in both countries X and Y must be identified. Only the first application for each aspect of the invention needs to be identified provided all applications on that aspect were filed within one year prior to the U.S. filing.

(iii) If a non-priority application is being filed you must list all applications in all countries where corresponding foreign applications were filed more than one year prior to the U.S. filing. This is so the Examiner can check to see if any of those applications were published or patented early enough to be prior art against the U.S. application.

(iv) If there are more than two applications to be listed we suggest that you type in on this form only "See attached Schedule A" and then list all of the previous applications on an attached sheet.

line 12b Is used to claim priority under 35 USC §119(e) based on a provisional application filed within one year of the filing of the instant application. More than one provisional application may be identified provided neither was filed more than one year earlier.

line 13 This block is used only in instances where there is a previously filed U.S. non-provisional application which was copending at the time the present application was (or is being) filed. That previous application could be a U.S. non-provisional application or the National Phase of a PCT allocation. In such a case the present application may be entitled to the priority of the previous application's U.S. filing date (and consequently the foreign priority thereof) provided the present application is identified as a continuing application (continuation, divisional or continuation-in-part) of the earlier (parent) application. If the foregoing is applicable, please fill in one line for each such prior application.

line 14 Type the inventor's proper legal name in the order specified, e.g., "John B. JONES" or "J. Bob JONES" if the inventor so prefers. It is not acceptable to use only initials such as "J. B. JONES."

line 15 The inventor's "signature" may be his (or her) usual manner of signing but it is preferable that the inventor simply write his (or her) name in his (or her) own cursive handwriting in the same order as on line 14, e.g., given name, middle initial and family name.

line 16 Insert the actual date of signature.

line 17 Insert simply the city and state or country, e.g., "Paris, France", of the inventor's residence, not citizenship. No street address or postal code is required on this line.

line 18 Insert the inventor's citizenship. The statement of citizenship (or subject of) is a statutory requirement (35 USC §115). Simply the name of the country of citizenship, e.g., "Japan" is sufficient.

line 19 Insert the inventor's mailing address. The purpose of requiring the post office address is to enable the Patent Office to communicate directly with the inventor if desired, such as in the case of death of the U.S. attorney. It should be the address where the inventor customarily receives his (or her) mail and should include the postal code. If applicable it can be the inventor's business address or address at place of employment.

Applicants are reminded that the U.S. Patent and Trademark Office has very strict requirements as to proper execution of an application. The applicant should make sure that he reviews the declaration, prior to signing to make sure the declaration properly identifies the application and all relevant information; and should review the specification and claims (including drawings, if any) before signing the declaration. Failure to do so will require the filing of a supplemental declaration --- 37 CFR §1.67(c).

Any handwritten changes to the specification, claims or drawings must be in ink personally by all of the inventors prior to signing the declaration and the adjacent left margin must be initialed and dated by all of the inventors, e.g., "JBJ 6-9-91".

Please let us know if there are any questions regarding proper completion of this form. Thank you.

An assignment, a separate document requiring separate signature and dating may be enclosed. Please look for it and sign and date it in the same manner as in lines 15 and 16 above.

STEVENS, DAVIS, MILLER & MOSHER, L.L.P.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful statements may jeopardize the validity of the application or any patent issuing thereon.

PAGE 2 OF U.S.A. DECLARATION FORM

14a	Typewritten Full Name of Sole or First Inventor	<u>1-11</u> <u>Hideki</u> <u>KANEMOTO</u> Given Name Middle Name Family Name
15a	Inventor's Signature	<u>Hideki Kanemoto</u>
16a	Date of Signature	<u>1</u> <u>19</u> <u>2001</u> Month Day Year
17a	Residence	<u>Yokosuka-shi</u> <u>SPX</u> <u>Kanagawa</u> <u>JAPAN</u> City State or Province Country
18a	Citizenship	<u>JAPAN</u>
19a	Post Office Address (Insert complete mailing address, including country)	<u>6-2-801, Hikari no Oka, Yokosuka-shi,</u> <u>Kanagawa 239-0847 JAPAN</u>
14b	Typewritten Full Name of Sole or First Inventor	<u>2-00</u> <u>Osamu</u> <u>KATO</u> Given Name Middle Name Family Name
15b	Inventor's Signature	<u>Osamu Kato</u>
16b	Date of Signature	<u>1</u> <u>19</u> <u>2001</u> Month Day Year
17b	Residence	<u>Yokosuka-shi</u> <u>SPX</u> <u>Kanagawa</u> <u>JAPAN</u> City State or Province Country
18b	Citizenship	<u>JAPAN</u>
19b	Post Office Address (Insert complete mailing address, including country)	<u>5-45-G302, Shonantakatori,</u> <u>Yokosuka-shi, Kanagawa 237-0066 JAPAN</u>
14c	Typewritten Full Name of Sole or First Inventor	_____ Given Name Middle Name Family Name
15c	Inventor's Signature	_____
16c	Date of Signature	_____ Month Day Year
17c	Residence	_____ City State or Province Country
18c	Citizenship	_____
19c	Post Office Address (Insert complete mailing address, including country)	_____ _____
14d	Typewritten Full Name of Sole or First Inventor	_____ Given Name Middle Name Family Name
15d	Inventor's Signature	_____
16d	Date of Signature	_____ Month Day Year
17d	Residence	_____ City State or Province Country
18d	Citizenship	_____
19d	Post Office Address (Insert complete mailing address, including country)	_____ _____

*Note to Inventor: Please sign name on line 15 exactly as it appears in line 14 and insert the actual date of signing on line 16. If there are more than four inventors, please add a copy of this page for identification and signatures for the additional inventors.